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Task Force 3: Training in Cardiac Catheterization and Interventional Cardiology

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There should be three levels of training to reflect the three different types of cardiology consultant functions: 1) the trainee not planning to do cardiac catheterization or angiography; 2) the trainee planning to perform diagnostic cardiac catheterization and angiography; and 3) the trainee planning to perform diagnostic cardiac catheterization, angiography and cardiac catheterization-based therapeutic or interventional procedures, such as angioplasty, atherectomy, coronary stenting or similar procedures as they develop.

General Aspects of Training

Cardiac catheterization, angiography and catheterization-based interventional procedures are essential parts of modern clinical cardiology practice. Therefore, all cardiologists must be knowledgeable in these areas. The trainee performing diagnostic cardiac catheterization and angiography requires additional training to obtain basic and clinical knowledge, judgmental skills and the technical competence requisite for performing these studies. The trainee who performs catheterization-based therapeutic or interventional procedures requires additional training in these special procedures beyond training in basic cardiac catheterization and angiography. Training in peripheral angiography/intervention may be undertaken at selected institutions where faculty expertise exists. Recommendations for such training have been published elsewhere (1).

Components of Training

Level 1

All trainees should have a clear understanding of the indications, limitations, complications and medical and surgical implications of the findings at cardiac catheterization and angiography, as well as a general understanding of related interventional procedures. This includes an understanding of the pathophysiology of cardiovascular disease and the ability to interpret hemodynamic and angiographic data and to use these data to select cases for surgical and catheterization-based therapeutic procedures. All trainees must have a basic understanding of and formal training in radiation physics, radiation safety, fluoroscopy and radiologic anatomy, as well as clinical cardiovascular physiology (e.g., pressure waveforms, shunt calculations, blood flow, resistance calculations). Trainees must learn to perform pulmonary artery catheterization with flow-directed catheters by both the cutdown and percutaneous (subclavian, femoral and internal jugular) routes. All trainees must be capable of performing temporary right ventricular pacemaker insertion and should have some experience performing right and left heart catheterization, including ventriculography and coronary angiography. In addition, they should learn to perform pericardiocentesis.

Level 2

Trainees who plan to perform independent catheterization and angiography require additional training in both percutaneous arterial entry and arterial incision and repair. They must receive additional education regarding the theoretic and practical aspects of radiation physics and safety. A working knowledge of catheterization laboratory equipment, including physiologic recorders, pressure transducers, blood gas analyzers, image intensifiers and other X-ray equipment, cine processing, digital imaging and quality control of films, is requisite. An understanding of the fundamental principles of shunt detection, cardiac output determination and pressure waveform recording and analysis is mandatory. Trainees should receive training in the techniques of endomyocardial biopsy and intraaortic balloon counterpulsation insertion and management. Catheterization of patients with complex congenital heart disease will require specialized training to include at least 1 month of rotational training in the pediatric catheterization laboratory.

Level 3

Trainees planning to do coronary or other cardiovascular interventional procedures must also have knowledge of the indications, limitations and complications of these procedures as well as an in-depth understanding of the specialized equipment

needs. Trainees must obtain specialized experience in the performance of the specific interventional therapeutic and diagnostic procedures, in addition to their basic training in coronary angioplasty after meeting the qualifications previously outlined.

Structure of the Training Program

Faculty

To ensure quality control of training and diagnostic studies, the training program must have a director of the catheterization laboratory who has primary responsibility for administration and teaching in the laboratory. There should be more than one competent faculty cardiologist participating in the cardiac catheterization training of the fellows. The director of the catheterization laboratory must be board certified in cardiovascular diseases or have equivalent credentials. All faculty responsible for training in adult cardiac catheterization should be board certified or board eligible by the American Board of Internal Medicine (ABIM) Subspecialty Board on Cardiovascular Disease and recognized as experts in cardiac catheterization. For training in catheter-related interventions (i.e., angioplasty, atherectomy, stenting, balloon valvuloplasty, transseptal procedures), there must be at least one cardiologist on the faculty recognized by his or her peers as an expert in the technique(s) for which training is offered.

Facilities

A fully equipped and staffed angiographic and hemodynamic laboratory dedicated to cardiologic procedures is required. Cardiovascular surgery must be performed in the training institution. All training facilities must be equipped, staffed and function in accordance with the 1991 ACC/AHA Guidelines for Cardiac Catheterization and Cardiac Catheterization Laboratories (2).

Patients

All trainees should be exposed to adult patients with valvular, congenital, cardiomyopathic, pericardial and coronary artery disease. The trainee planning a career in the catheterization laboratory must be trained to perform studies in chronically and acutely ill patients, such as those with cardiogenic shock, acute myocardial infarction or unstable angina.

Duration of Training

All trainees should have at least 4 months of training in the catheterization laboratory, during which time they must participate in the catheterization of at least 100 patients with whom they are involved from precatheterization clinical evaluation to final disposition (level 1). This training will not qualify the trainee to perform independent cardiac catheterization and angiography. For the trainee who plans to perform independent diagnostic cardiac catheterization and angiography, a minimum of 12 months of training in the catheterization laboratory is required, during which time a minimum of 300 procedures must be performed, including 200 with primary hands-on responsibilities (level 2). These 12 months may be distributed throughout the 3-year formal fellowship. For the trainee who plans to perform coronary or other cardiovascular therapeutic interventional procedures, a fourth year of training is required, and a minimum of 300 coronary interventional procedures must be performed, including 125 with primary responsibilities (level 3). It is assumed that most of these procedures will utilize balloon angioplasty. Research must be performed as well. For training in other interventional procedures, formal didactic training and at least 10 or more additional cases focused on the specific procedure are needed.

Content of Conferences

All trainees, regardless of subsequent career goals (i.e., clinical cardiology, diagnostic catheterization or catheterization-related interventional procedures), must attend a regular cardiac catheterization conference. It is important that the cardiologist understand the complexities and limitations of the findings in the hemodynamic and angiographic laboratory. Formal or informal conferences should stress the relation of historical and physical findings to the hemodynamic and angiographic criteria for selection of patients for therapy (i.e., medicine, surgery, angioplasty and so forth). Interaction with the cardiac surgeons at these conferences is important. The trainee should be familiar with the rationale for patient selection for these diagnostic studies and should be required to attend conferences at least weekly for the duration of the catheterization training period. The role of noninvasive physiologic testing must be put into perspective in the setting of these conferences. Regular morbidity and mortality conferences are a requirement for a training program.

Trainee Evaluation

Case selection and procedural judgment, as well as interpretive and technical skills, must be evaluated in every trainee. This is particularly important for the trainee who eventually will work full time in a diagnostic catheterization laboratory or perform interventional procedures. Quality of clinical follow-up, reliability, complications, interaction with other physicians, patients, laboratory support staff, appropriate initiative and ability to make independent and appropriate decisions are to be considered.

The competency of all cardiology trainees in cardiac catheterization should be documented by both the program director and the director of the cardiac catheterization laboratory. The program director has the responsibility to confirm or deny the technical competency and catheterization laboratory exposure of trainees. The granting of hospital privileges remains within the purview of the individual institution.

Evaluation of the trainee who desires special training in

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diagnostic cardiac catheterization and angiography shall include documentation (in the form of a logbook*) of the performance of a minimum of 300 procedures, 200 as primary operator (Level 2).

Evaluation of the individual training in catheterization-related interventional procedures shall, in addition, include documentation (in the form of a logbook*) of the performance of a minimum of 300 procedures in angioplasty, 125 with primary responsibilities (Level 3).

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*The logbook should contain clinical information, procedure performed and outcome of procedure, including complications.

Task Force 4: Training in Echocardiography

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Echocardiography is currently the most widely used imaging technique for assessing cardiovascular anatomy and function. Clinical application of ultrasound encompasses M-mode, two-dimensional, pulsed and continuous wave Doppler and color flow imaging. Echocardiography (like invasive catheterization) provides information concerning cardiovascular 1) anatomy, 2) function (i.e, ejection fraction), 3) hemodynamic variables (i.e., gradient, pressure), and 4) flow disturbances by means of pulsed and color flow Doppler imaging. Today an echocardiography laboratory can appropriately be called an ultrasound imaging and hemodynamic laboratory.

Fellowship training in echocardiography should include instruction in the basic aspects of ultrasound, but only those fellows who go beyond the basic level are trained sufficiently for independent interpretation of echocardiographic studies. Every trainee should be educated in the physical principles and instrumentation of ultrasound and in cardiovascular anatomy, physiology and pathophysiology, both with regard to the cardiovascular system in general and in relation to the echocardiogram in particular. At all levels of training, trainees should be required to perform the echocardiographic and Doppler examination to integrate their understanding of three-dimensional cardiac anatomy. Trainees should be encouraged to correlate the findings from the echocardiographic and Doppler examination with the results of other imaging modalities and physical examination. The trainee should master the relation between the results of the echocardiographic examination and findings of other cardiovascular tests, such as catheterization, angiography and electrophysiology. Exposure to computer sciences and bioengineering may also be beneficial. The trainee should also master the relation between the results of the echocar-